AFRICAN UTILITY WEEK | CLEAN POWER AFRICA

Eskom

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Eskom LSES Facility

- Eskom presently has 3 energy storage facilities using Pumped Storage, namely, Palmiet (400MW for 28 hrs), Drakensberg (1000MW for 28 hrs) and Ingula (presently under construction at 1333MW for 14 hours)
- Eskom has been looking at alternative means to store energy for the last 15 years, resulting in the formation of the Large Scale Energy Storage Portfolio, some 8 years ago.
- Technologies considered range from mechanical storage to batteries, chemical storage, thermal energy storage and super-capacitors.
- Batteries are considered the most likely alternative means of storage in the future. Presently NO technology can match the cost per lifetime k|Wh of pumped storage.

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- Eskom will need to become more flexible and may become the supplier of last resort by the year 2030
- 8400MW of wind generation and 8400MW of solar PV generation in the grid as per IRP 2010.
- Neither solar PV, nor wind can be regarded as despatchable resources
- Cannot be relied upon to supply a constant source of energy
- Eskom anticipates only an average load factor of 27% from its Cere Wind Farm.

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- Solar PV can only generate at a maximum load factor of 25%
- The solar production is not available for the maximum demand period of 6-9pm in the evening.
- Eskom will therefore be expected to meet the full load demand during this period without support from the solar PV generators.
- When solar irradiation is low, clouds pass over, or the sun does not shine Eskom must make up the shortfall (up to 75% fluctuations).
- When the output fluctuates, Eskom must stabilise the grid.
- When solar output is at its maximum, Eskom will be expected to reduce its output to accommodate the solar generators.

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- If the wind does not blow on any given day, Eskom will be expected to pick up the supply shortfall.
- If the wind is gusty, Eskom will be expected to accommodate the fluctuations in supply.
- If the wind is ideal and the wind farm is at maximum output, Eskom will be expected to reduce its supply.
- People want their lights on when the sun does not shine.

TO ACHIEVE THIS ESKOM WILL NEED TO INSTALL MORE ENERGY STORAGE.

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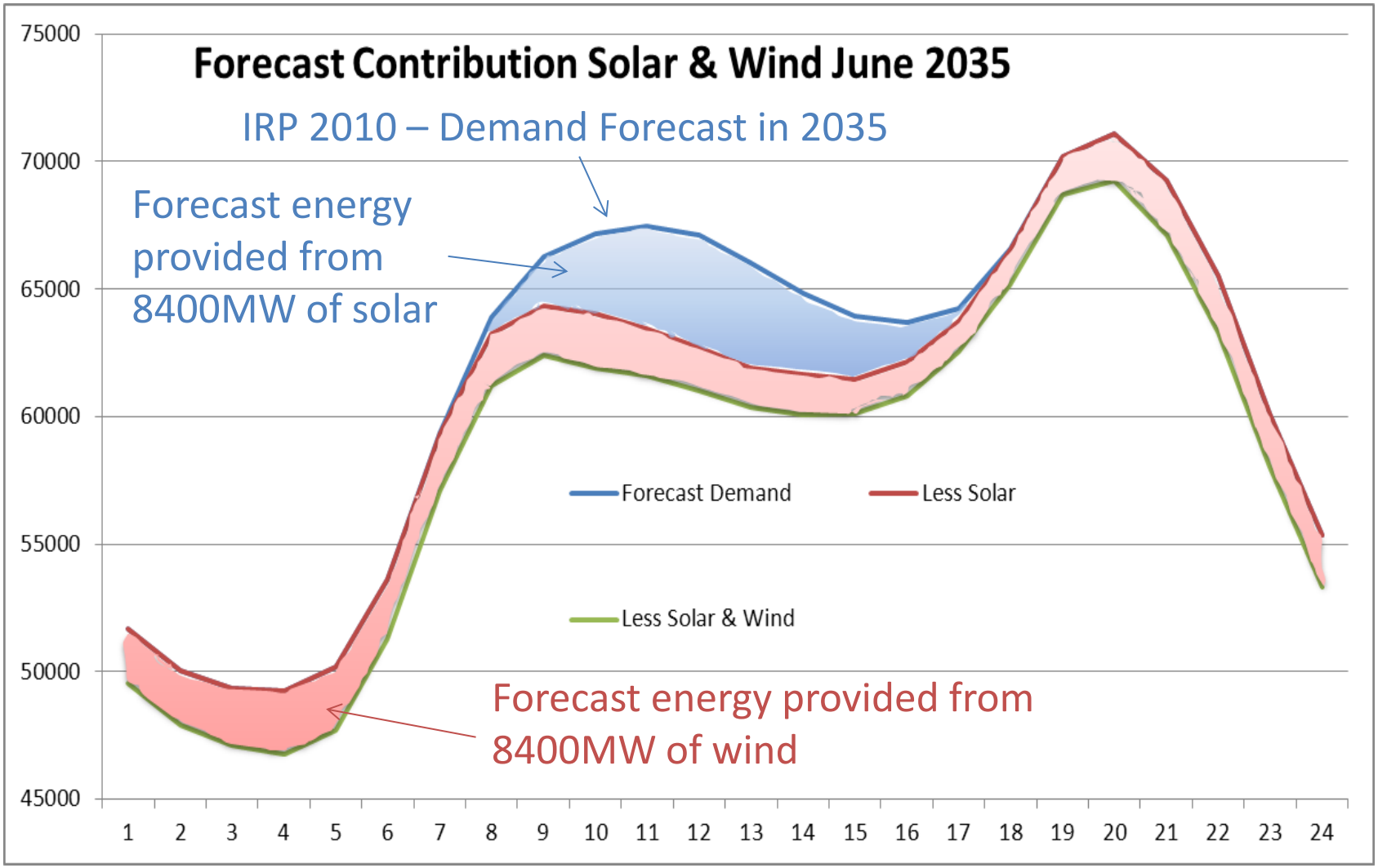

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- Eskom will be required to have considerably more flexibility in its generation mix.
- By 2030 Eskom will need to able to accommodate fluctuations of as much as 16.8GW during the day and also meet a peak demand of up to 12GW (July).
- Base load stations, nuclear and coal fired can accommodate some fluctuation in load but at a high cost.
- Nuclear should ideally be operated at almost full load.
- Coal fired generators can vary their load between 100% output and 60% with less efficiency loss than Nuclear, but increased CO_2 per kWh produced.

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- Without substantial sources of natural gas, the operation of open cycle gas turbines, which can be switched on and off at will and can fluctuate their output, is extremely expensive.
- The current cost is approximately R5/kWh, or more than 12 times the cost of base load generation.
- One source that may prove more economic is the use of Combined Cycle Gas Turbines, using UCG technology on Eskom owned mines.
- It is therefore believed that this flexibility will need to be supplied by energy storage.

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- Eskom's present method of storing energy is using pumped storage schemes
- Eskom presently has 3 such schemes, totalling 2 700MW, once the Ingula scheme is completed
- A further scheme has been proposed at Steelepoort, providing 1 600MW of storage
- Pumped storage can only be installed at discrete locations with suitable geography
- A network of large batteries could be the solution to Eskom's needs for increased flexibility
- Up to 4 000 discrete battery units of 1MW, 6-8MWh

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- The installation of battery energy storage systems is presently uneconomical
- Battery energy storage system costs are an order of magnitude greater than the cost of pumped storage on a cost per lifetime kWh basis.
- Future developments (flow batteries, Ambri's liquid battery, EOS's zinc air battery or Aquion's aqueous sodium ion battery are all forecast to be up to 10 times cheaper than present costs.
- Eskom must determine the REAL performance of these batteries prior to widespread installation, especially in view of the current costs. Comparative testing is therefore essential.

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The objectives of the project are as follows ;

1. Demonstrate the effectiveness of battery energy storage at a grid scale.
2. Test individual battery technologies under real operating test regimes
3. Identify the best technology for various applications
4. Establish the probable life cycle of each of the various technologies under real working conditions
5. Establish the round trip efficiencies of the various units
6. Give Eskom insight into the future installation of commercial battery storage units of the Megawatt scale.

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- Eskom's Test and Demonstration Facility has been designed to accommodate 5 batteries of differing technologies and manufacturers, which will all be tested under identical load discharge profiles over a minimum period of 3 years.
- The output of the 5 units is then synchronized and fed back into the grid, as if they were a single 1MW battery unit, in order to demonstrate the effectiveness of this form of energy storage.
- At the end of the 3 year period, suppliers must guarantee an output of at least 96% of the nameplate performance.

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- PICTURE

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Basic characteristics

Nominal Voltage 3.20V

Normal Capacity 220Ah

Energy 704Wh

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- Unit 1 is a lithium ion phosphate battery supplied by BYD of China
- 10 strings of 280 cells in Parallel operating at 945VDC
- Unit 2 is a sodium nickel chloride battery supplied by General Electric of the USA
- We are presently negotiating to install 2 further flow battery technologies, that will be tested on behalf of their suppliers, as an independent third party test facility.
- There is space for one further unit, although additional units could be added at an adjacent area to the test facility at a later date.

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The test protocols developed so far include –

- Site Acceptance Test – The unit will be cycled daily with a two hour discharge period in the morning, 4 hour discharge in the evening and a 7 hour overnight charge. This test will be repeated 90 times.
- PV Cloud Compensation – A second by second survey of the output of a 400kWp solar system during an intermittently cloudy day, plus load shifting will be repeated for 90 days.

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Further test protocols will be developed for the following applications -

- Actual second by second data has been collected from an active windfarm over a 24 hour period. This data will be integrated into a second by second profile, together with an element of load shifting.
- Actual data from an average solar day, plus load shifting
- Frequency control, plus load shifting
- Grid voltage support, plus load shifting

Over the 3 year test period it is anticipated that the batteries will perform over 1 000 nameplate cycles.

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THANK YOU